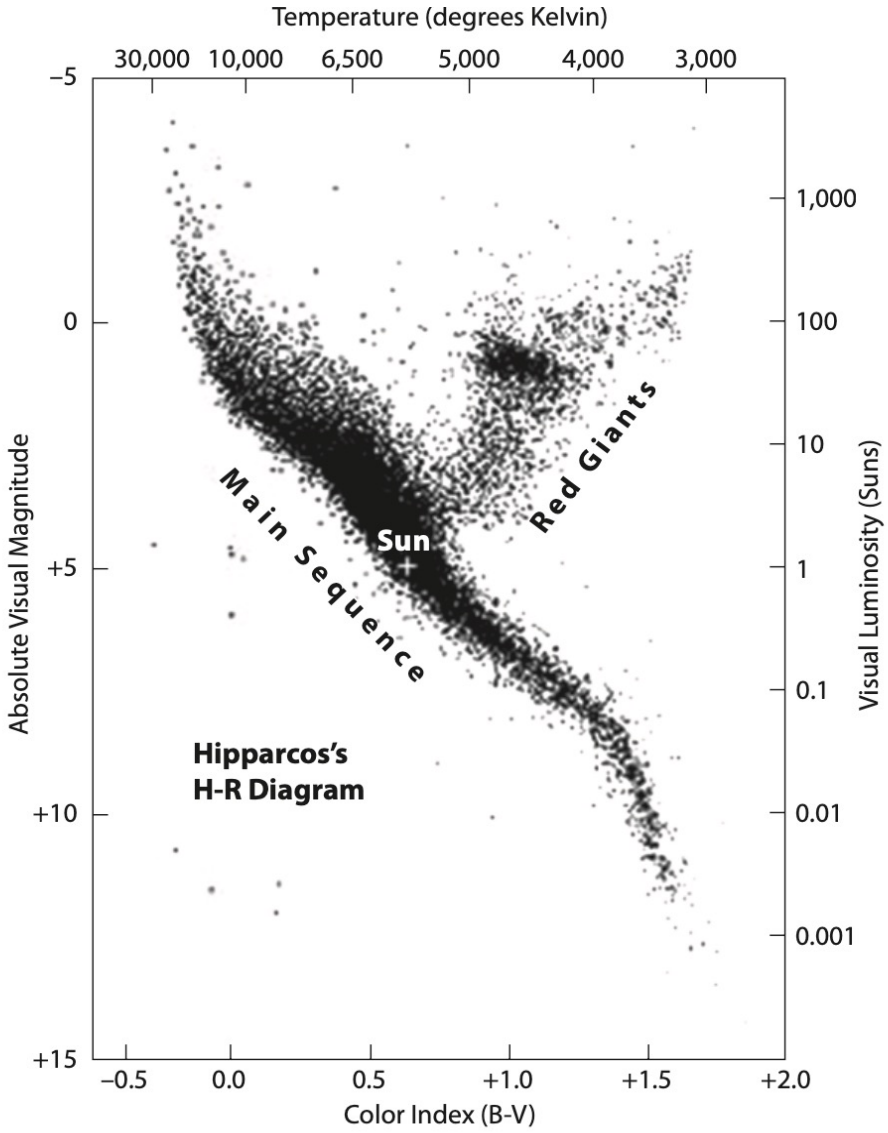
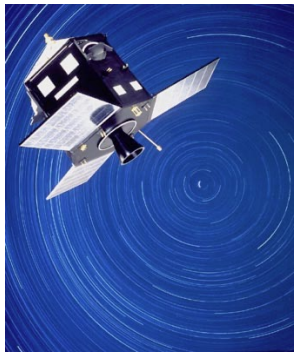
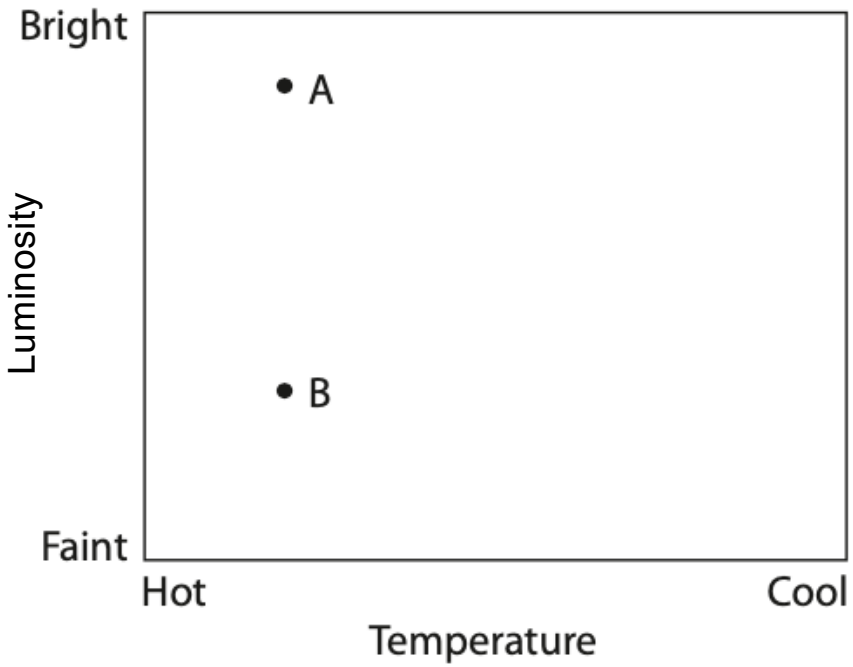
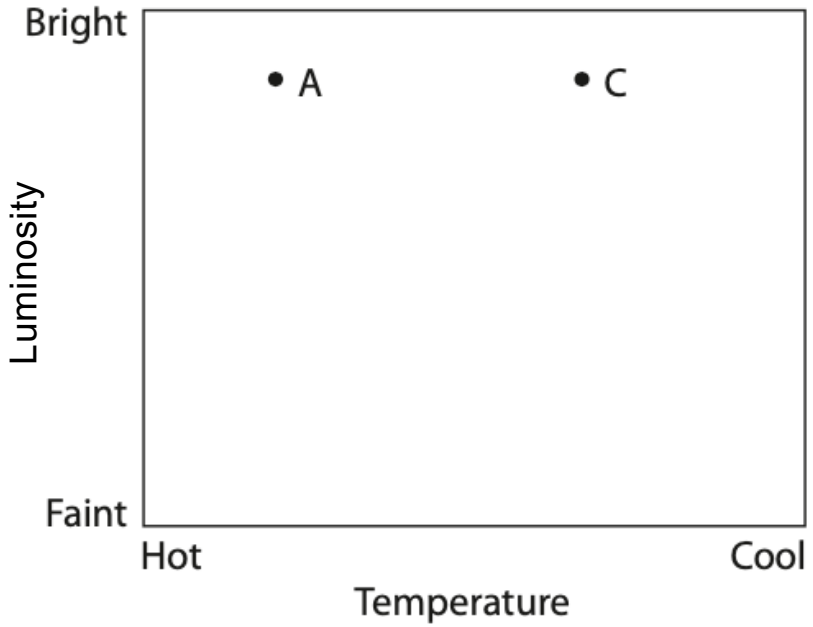

Temperature (degrees Kelvin)
30,000
10,000
6,500
5,000
4,000
3,000
−5
0
+5
+10
+15
Absolute Visual Magnitude
1,000
100
10
1
0.1
0.01
0.001
Visual Luminosity (Suns)
Red Giants
Main Sequence
Sun
Hipparcos's
H-R Diagram
−0.5
0.0
0.5
+1.0
+1.5
+2.0
Color Index (B-V)



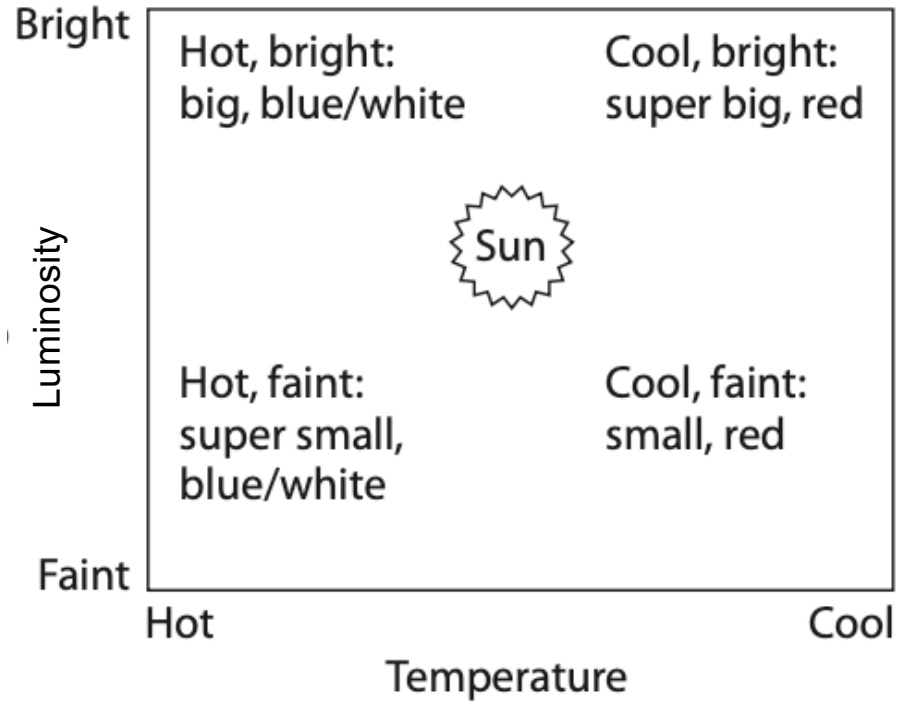
Comparing Up with Down

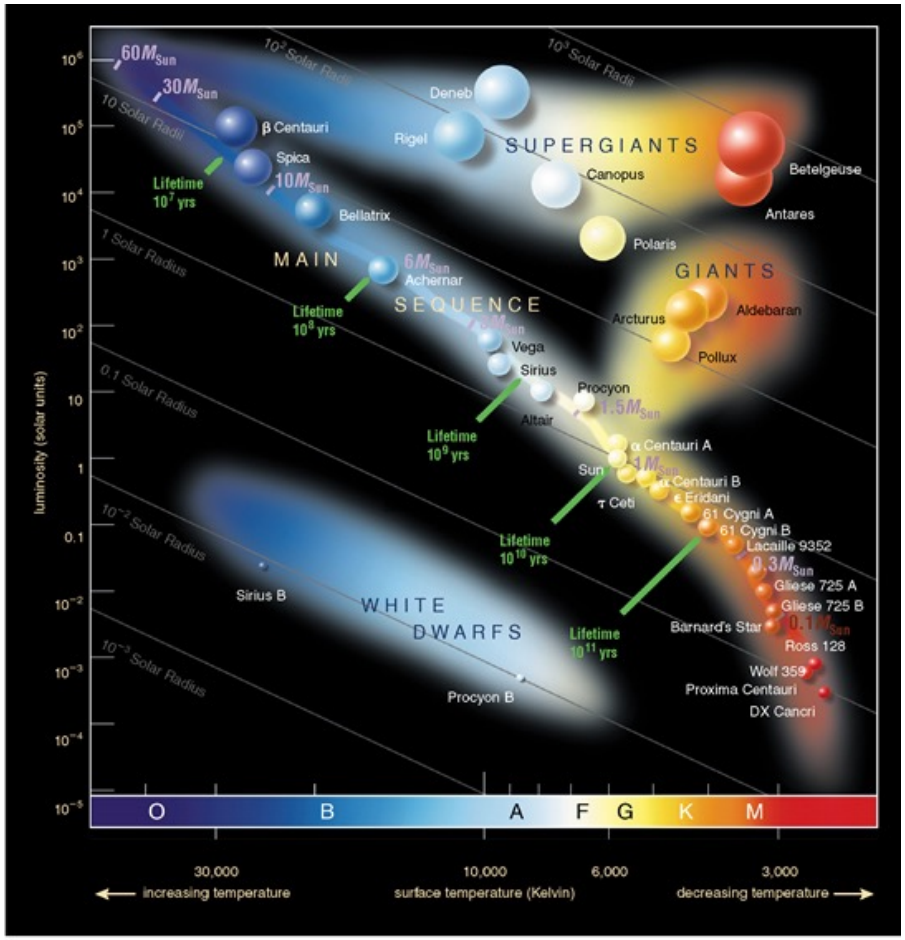


Comparing Left with Right



Relative Properties




luminosity (solar units)
10^6
10^5
10^4
10^3
10^2
10
1
0.1
10^{-2}
10^{-3}
10^{-4}
10^{-5}
$60M_{Sun}$
$30M_{Sun}$
$10M_{Sun}$
$6M_{Sun}$
$1.5M_{Sun}$
$1M_{Sun}$
$0.3M_{Sun}$
$0.1M_{Sun}$
10^3 Solar Radii
10 Solar Radii
1 Solar Radius
0.1 Solar Radius
10^{-2} Solar Radius
10^{-3} Solar Radius
Deneb
Rigel
SUPERGIANTS
Canopus
Betelgeuse
Antares
Polaris
β Centauri
Spica
Bellatrix
Lifetime 10^7 yrs
MAIN
SEQUENCE
Achernar
Lifetime 10^8 yrs
GIANTS
Arcturus
Aldebaran
Pollux
Vega
Sirius
Procyon
Altair
Lifetime 10^9 yrs
α Centauri A
Sun
α Centauri B
ε Eridani
τ Ceti
61 Cygni A
61 Cygni B
Lacaille 9352
Gliese 725 A
Gliese 725 B
Barnard's Star
Ross 128
Wolf 359
Proxima Centauri
DX Cancri
Lifetime 10^{10} yrs
Lifetime 10^{11} yrs
Sirius B
WHITE
DWARFS
Procyon B
O
B
A
F
G
K
M
30,000
increasing temperature
10,000
surface temperature (Kelvin)
6,000
3,000
decreasing temperature

How to Put a Star on the H-R Diagram

What numbers do we need?

- Absolute magnitude (or luminosity)
- Temperature (or color)

How to Put a Star on the H-R Diagram

What numbers do we have (observe)?

How to Put a Star on the H-R Diagram

What numbers do we have (observe)?

- Parallax (angle)
- Apparent magnitude
- Spectral type or color

What Do We Do?

- from parallax: calculate distance
- from apparent magnitude and distance: calculate absolute magnitude
- from color we can determine λ_{max} or from comparison of spectrum with known spectral 'standards': calculate temperature

$$m - M = 5\log(D) - 5$$

$$\mathrm{D} = \frac{1}{\theta}$$

$$\lambda_{max} = \frac{0.0029mK}{T}$$

Let's Calculate It!

- θ = 0.01". What is distance?

$$D = \frac{1}{\theta}$$

- m = 7. What is absolute magnitude?

$$m - M = 5\log(D) - 5$$

- λ_{max} = 350 nm. What is temperature?

$$\lambda_{max} = \frac{0.0029mK}{T}$$

Let's Calculate It!

- θ = 0.01". What is distance?
- 100 pc

$$D = \frac{1}{\theta}$$

- m = 7. What is absolute magnitude?
- M = 2

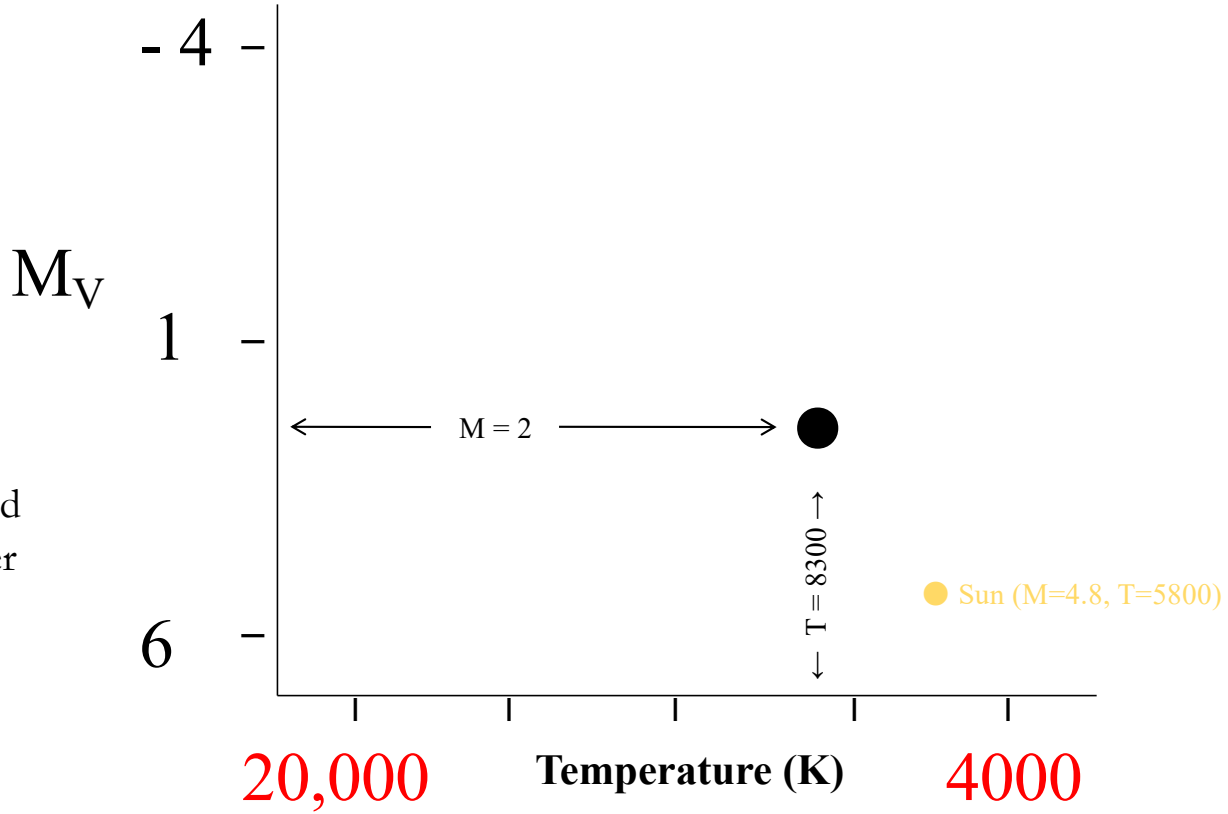
$$m - M = 5\log(D) - 5$$

- λ_{max} = 350 nm. What is temperature?
- T = 8300 K

$$\lambda_{max} = \frac{0.0029mK}{T}$$

Place the Star on the H-R Diagram

This enables us to determine its evolutionary state and compare it with other stars.

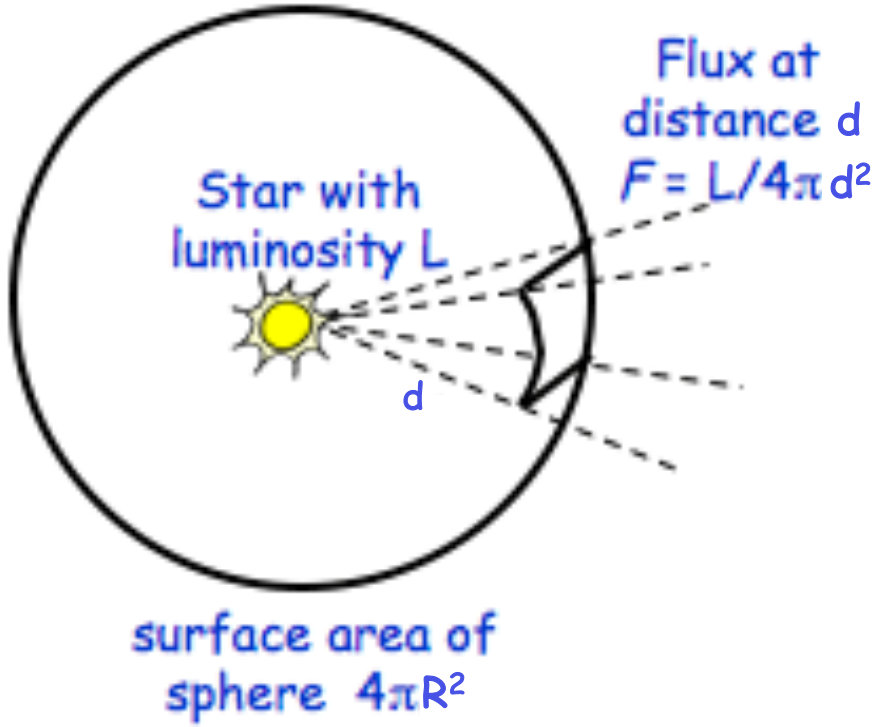


Considering Luminosity

Flux

The measure of stellar luminosity received by a detector at a distance d from the star (i.e. the brightness of a star measured on Earth)

$$F = L/4\pi d^2$$



Luminosity: Light Given Off in all Directions

Luminosity (L): Total light emitted from the source in Joules/second (Watts)

Intrinsic to the Star

$$L = 4\pi r^2 \sigma T^4$$

$\sigma = 5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$

Stefan-Boltzmann constant

r = radius (m)

T = temperature (K)